DESIGN AND IMPLEMENTATION OF DECISION SUPPORT SYSTEMS IN THE PUBLIC SECTOR

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CISR WP #118
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ABSTRACT

This paper examines the implications of utilizing decision support systems (DSS) in the public sector based on a DSS developed and implemented for a community mental health system. The DSS includes a multiple objective (goal programming) allocation model and encompasses a multiple party decision process. The experiences and insights acquired during the development and implementation are relevant to public sector decision support, in general. The importance of a DSS as a process-support aid rather than simply providing answers (i.e., a product-oriented aid) and the interaction of system architecture and the chosen design strategy are key insights. In particular, the distinction between model-oriented and data-oriented DSS does not appear to be appropriate. The public sector decision maker's concern with issues of equity requires the ability to operate in a higher dimensional framework than the typical spread sheet model and there is a critical need for communication support.

1. Introduction

Developing and implementing decision aids in the public sector is a challenging task. As Lamm (1980) and others have pointed out, the political process tends to promote those that survive or win, not those seeking truth. Often, the essential benefit of a decision aid, a valid model, is the very element that most threatens the survival of the public decision maker. It is not surprising that Brill (1979) notes, "Designing a solution to a public sector problem is largely an art."

Hammond (1980) suggests that it may not be sufficient to provide decision aids unless explicit attention is given to how these aids support effective learning. Without effective learning support, Hammond (1980), Pressman and Wildavsky (1979) and others predict dysfunctional consequences are likely to result from our policy making processes. Although Hammond argues a quasi-experimental approach is a necessary condition for learning, he notes that the strong quasi-rational model of inquiry represented by the application of management science techniques has had positive impact on public sector decision making. For example, management science models can help to externalize multiple objectives and when combined with the results of quasi-experiments provide an enhanced learning environment.

The need to facilitate access to decision aids as well as support individual and organizational learning is explicitly addressed in the decision support systems literature (Sprague and Carlson, 1982) and (Alavi and Henderson, 1981). As Keen and Scott-Morton (1979), Alter (1980) and others note, the basic design strategy for DSS begins with an analysis of the decision process and adaptively develops a tool for the user to learn about and cope with semi-structured decisions.

Experience in DSS design has also indicated the importance of flexibility, ease of use (at least by an intermediary), and adaptability. Design methodologies such as middle-out (Ness, 1975) or prototyping (Keen and Gambino, 1981) are explicitly directed towards achieving these characteristics. These design approaches assume there will be significant user and analyst learning both in terms of the technology as well as with regard to the decision process. This learning is enhanced (perhaps even made possible) by developing an initial system with the characteristics described above. As both the user and analyst move along a learning curve, the system is adapted to support their evolving information and learning needs.

The trend in public sector applications of management science techniques seems consistent with this perspective. Public sector planning models have evolved from those that focus on efficiency to those that attempt to describe and account for conflicting objectives (ReVelle et al. 1977). The application of multiobjective models in areas such as fire station location (Schilling et al., 1980), policy patrol scheduling, (Saladin, 1980) and water resource management (Major and Lenton, 1978) are some recent illustrations. Recursive frameworks (Henderson et al., 1978; Cohon and Marks, 1973) have been proposed that use a multiobjective planning model to establish system parameters and then disaggregate these solutions using heuristic and simulation models in order to evaluate their impact on system operations. This iterative approach is quite consistent with the adaptive design concepts proposed by DSS researchers.

Research on the application of decision support systems in the public sector has also emphasized the need to address both the problems of conflicting objectives as well as the need to better support the traditional data analysis efforts of the policy analyst. Hammond (1980) notes that both forms of decision

aids are necessary. Providing these types of decision aids in a user friendly, adaptive mode is the objective of many current research efforts.

This paper investigates the impact of implementing a decision support system in the public sector. Section 2 describes the specific setting for which the DSS was designed and implemented. Section 3 discusses the multicriteria allocation model embedded in the DSS and the overall DSS design. Section 4 elaborates on the organizational decision process, while section 5 presents the results of implementing the DSS and discusses its impact during the first two years of actual use. Finally, section 6 provides some concluding remarks.

2. The Mental Health System

This research will focus on a decision support system designed and implemented for the Franklin County (Ohio) Mental Health and Retardation Board. The Board oversees forty contract agencies which provide required community-wide mental health services. The nature of the decision process for allocation decisions is critical to the Board in this environment. There must be opportunities for various constituencies, representing diverse interests, to have influence on complex programmatic and financial decisions. Unfortunately, within this realm of complexity, the decision makers are often untrained. They are chosen based on the constituencies and values they represent, rather than on their knowledge of the problem area or expertise as planners or decision makers. They serve in a voluntary mode, meeting infrequently and typically, under severe time constraints. It is little wonder that decisions often reflect the relative power of a special interest group rather than some overall set of community goals and priorities.

The Franklin County MHR Board, faced with increasing demand and an eroding resource base,[1] began an effort to improve the quality of their budget planning and allocation process. They identified a need to clarify goals and link these goals to a comprehensive model for mental health delivery. They sought a budget process that would provide Board members with a better understanding of how specific allocations affected program level and overall community mental health system goals.

As a starting point, they chose the Balanced Service System (BSS) model as the fundamental conceptualization of a mental health service system. The BSS is a model of mental dysfunctioning used by the Joint Commission on Accreditation of Hospitals (JCAH) to generate standards for community mental health programs. In its basic form the BSS model consists of two primary dimensions: The service <u>function</u> (crisis stabilization, growth, and sustenance) and the service <u>environment</u> (protective, supportive, and natural). The function indicates the nature of the service while the environment describes where the service is provided. Each of 200 possible service types are assigned to one of the cells of this two-dimensional matrix. Figure 1 depicts this matrix and includes examples of the type of services in each cell. This model satisfies requirements for a comprehensive mental health framework and also provides the basis for externalizing Board goals. As will be discussed, the goal structure addresses both specific program areas (e.g., a particular cell in the service delivery matrix) and systemwide goals (e.g., the need to balance service delivery across a range of service environments).

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[1]The Board's allocations budget is approximately 20 million dollars. However, projections for budget cutbacks and inflation are significantly reducing these resources while various need assessments indicate increasing demand for service.

Insert Figure 1 About Here

The Board also recognized the need for an adequate decision aid. They began an effort to develop a decision support system that would: (1) provide a direct link between Board goals (as formulated using the BSS model) and allocation decisions, (2) provide a means to better understand the tradeoffs between goals and the impact altering goal priorities, (3) provide the means to easily incorporate new restrictions, policies, or cost and service parameters into decisions, and (4) provide training tools for Board members.

Given these needs, a DSS design and implementation effort was undertaken. The following sections describe the resulting DSS and its impact.

3.1 DSS Framework

One of the basic concepts of DSS is the need for flexibility and adaptability (Keen and Scott-Morton, 1979). As many public sector researchers note (Brill, 1979), successful public sector decision aids must be able to accommodate unanticipated changes both to the structure of embedded models as well as to the nature of the user interaction. Achieving these system characteristics is a fundamental goal of the DSS designer. This flexibility and adaptability can be provided through a modular design. The system framework employed (Figure 2) is consistent with that proposed in Sprague and Carlson (1982). It consists of three basic components; model management, data management, and information management and provides for a user friendly interface. Each component is decoupled as much as possible and consists of a set of well-defined processing modules. This modularity minimizes the number of system interdependencies, thereby allowing most changes to be relatively localized and

straightforward. Further, various processing modules were written in a high level, analysis-oriented language (SAS). This language provides many data processing-oriented macro statements and parameterized routines which substantially reduce the time required to generate or modify particular system components. In cases where this language did not meet specific needs, the module was written in Fortran or a macro command language.

Insert Figure 2 About Here

While initial prototyping efforts focused on the development of a mathematical model, the eventual success of the DSS depended on effective, integrated software environment for each of the component systems. As will be discussed in Section 5, this would suggest appropriate system characteristics for DSS generators as well as give rise to questions on the validity of distinctions made in the DSS literature concerning model-oriented versus data-oriented decision support systems. To provide a background for these remarks, a brief description of each component is provided.

The model management component focuses on the generation and execution of the allocation model. A model generation module translates variable definitions, system structure and parameter estimates into an appropriate format for model execution. This module also provides a means to interface with the system transaction data base. Relatively extensive changes to the model can be accomplished by fairly simple adjustments to the model generation module.

The model execution module utilized IBM's MPS linear programming package. However, the flexibility of the model generator combined with the capabilities of the data management component permit the use of any appropriate linear programming software.

Finally, as with each component of the DSS, the model management component included processing modules to interface with the host operating system and provided for interactive dialogue with the user. This aspect, termed "system control," enables much of the operation of the model management component to be relatively transparent to the user and provides the means to integrate this component with other parts of the system.

The model management phase of the DSS generates a large, very detailed solution data base. As the DSS research notes, the model must be embedded in an appropriate information delivery system. The purpose of the second component, data management, is to provide the foundation for this delivery system by merging this solution data base with various other data bases (e.g., variable labels, historical data trends, etc.) in order to create an integrated solution data base. From this solution database selected application data bases are extracted for use by the application programs. These application data bases create significant efficiency in the subsequent information processing modules. It is important to note that this component decouples the generation and execution of the model from the generation of management information. It is, in fact, the role of a data management component to isolate changes to application programs from changes to primary data sources (in this case, changes to the allocation model).

The data management component also provides the means to access and analyze data stored in the system transaction data base. As will be discussed later, this capability proved necessary for the successful implementation of the DSS. A high level language (SAS) provided efficient processing of large files[2] as

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[2]The transaction data base contained over 500,000 records.

well as the ability to quickly adapt parameter calculations for both changes in problem structure and specific data sources.

The information processing component creates a wide range of managerial reports. To achieve adaptability and flexibility, this component consists of a number of applications programs that operate on extracted applications data bases. This structure permits modifications to a particular program or report to be localized and therefore greatly simplifies the adaptation of the information generation process. This component uses visual representations such as value paths (Schilling et al. 1982) and bar graphs to augment traditional tabular reports. The system allows easy manipulation of both the representation form as well as the particular format via a friendly user interface environment.

3.2 The Model

The complex and political nature of the allocations decision highlighted the utility of a model-based decison support system. The complexity arose not only from the great variety of allocations decisions required, but also from their interrelationships. These issues were addressed by formulating a linear programming resource allocation model.

The selection of an appropriate model structure was influenced by several considerations. First, the presence of lay decision makers and other non-technical users favored a model structure which was intuitive and, therefore, easy to understand. Secondly, due to the prototyping/evolutionary approach used in system development, the model had to be capable of extensive elaboration. Thirdly, the chosen structure should address the multiple objective nature of the decision problem, namely the competing Balanced Service System categories. Finally, it was important that the model help strengthen the behavioral link

between the newly adopted BSS framework and the decision maker's existing perceptions of system-wide needs.

In response to these desired characteristics, a goal programming model structure was selected. Goal programming has been used and tested in a wide variety of multiple objective decision problems with sophisticated users as well as novices. Such a model structure can respond well to an evolutionary development. In addition, the multiple BSS objectives could be represented in a straightforward fashion using county-wide service needs as goal levels. By directing the Board's attention towards balancing these services, the behavioral link between the BSS framework and a Board member's current cognitive model could be improved.

The model formulation follows a classic goal programming structure and is discussed in detail in Henderson and Schilling (1981). While the details of this model are not germane to this paper, a brief overview is provided so that the manner in which the DSS and the model evolved over time can be discussed.

The primary decision variables reflected the amount of dollars from each funding source allocated to each service type provided by each agency. There were four different sources of funds to be accounted for, resulting in over 500 variables. Besides the budget constraints which limited total dollars available from each funding source, restrictions were specified on the percentage increase and decrease that any agency's budget might change. Similarly, the total county-wide funding level for each service was limited in the amount that it might shift. These agency and service funding restrictions were included to insure that any allocations shifts would be politically feasible. For example, defunding an entire agency or service in a single year would be extremely difficult to implement. The Board specifically chose a strategy that would spread major funding level changes over several planning periods.

Legal restrictions were incorporated which addressed the legislative and contractual stipulations of specific funding sources. For example, federal regulations require that the proportion of federal funds to public funds must be no more than three to one.

Consistent with a goal programming approach, constraints were included that measured goal deviations and created an objective function minimizing the weighted deviations from the BSS goal levels. Since none of the goal levels was attainable given current or foreseeable funding levels, the deviations were all one-sided. The priority weightings of the deviational variables served as the tools for identifying group conflict and consensus formation as well as the mechanism by which the group could examine alternative allocation patterns.

While goal programming has seen numerous applications, it nonetheless has several potential pitfalls. Of most concern in this application is the possibility of solution manipulation, discussed by Harrald et al. (1978). In such a situation, arbitrary bounds are added to the model in an attempt to force acceptable solutions. This activity often occurs when the model is too simplistic and unrealistic. This problem can be particularly troubling in a prototyping implementation effort, where both the DSS and model evolve from a simple, first-cut system. In order to inhibit arbitrary manipulation, all proposed structural changes were subjected to extensive discussion and debate with Board and staff members. Changes were introduced only if a consensus opinion existed that the modification was a fundamental policy elaboration. For example, during initial development, two basic model improvements were made. It became apparent that the model ignored differences in services based on client age and area of residence. To rectify this inadequacy, constraints were added to insure that each client age group and geographic area received at least a minimum level of

funding. In another instance, it was determined that some services (termed 'supplemental') were required when (and only when) other basic services were purchased. Constraints were then written to reflect this observation. Both of these model changes were not attempts to contrive solutions but in fact represented evolutionary enhancements to the model which resulted from decision maker learning (see section 5). In support of these conclusions it is worth noting that these modifications are still present in the model three years later.

4. The Decision Process

In the public sector, the key word is often 'process.' The means by which a decision is reached can often receive more attention than the decision itself. In designing and implementing a DSS, issues of process become paramount. A common perception among users is that some of their decision making power may be sacrificed. For example, one of the byproducts of a model-based DSS is that decision criteria must be made more explicit. Attention is then directed toward the mechanism by which these criteria are established and applied. This externalization often represents a major change for public sector decision makers (Hammond, 1980).

The likelihood of successful implementation is increased as the magnitude of resultant change is decreased (Keen and Scott-Morton, 1979). To this end, minimizing unnecessary process modifications is very desirable. In the case of Franklin County, the planning and allocation process involved group decision making throughout. There was strong commitment among Board members to a planning process which utilized an interacting group to obtain a consensus. The Board members felt such an approach was both politically feasible and enhanced

the opportunity for debate and compromise. To avoid the pitfalls of interacting groups, such as dominance and rutting (Gustafson et al. 1973), an estimate-discuss-estimate procedure was used to generate goal weights, (Gustafson et al., 1973; Delbecq and Van de Ven, 1971).

This process calls for each committee member to review the results of a DSS analysis. Each member then assigns importance points (the sum of which equals one hundred) to the various goals.[3] The distribution and mean of the collective votes were tabulated and fedback to the group to stimulate discussion and promote conflict resolution. Following this debate, a second allocation of importance points occurred. This vote-discuss-vote sequence has been shown to be effective in estimating parameters and for facilitating group consensus (Delbecq et al., 1975). The average weights produced by the second voting were used as priority weights on the deviational variables in the goal programming model. The model was then solved to generate an allocation pattern, which was presented to the group and the vote-discussion-vote cycle was repeated.

This group process is the solution technique for the goal programming model. It is, essentially, a multi-party extension of a simple, iterative search technique for determining the appropriate weights on the objectives. Its relatively unsophisticated structure is easily understood by non-technical decision makers and it blends easily into the existing group process. This simple format provided an effective means to initiate the DSS prototyping effort.

As the implementation proceeded, the decision makers became quite comfortable with interpreting the goal weights. The DSS allowed the decision-makers to directly link changes in weights with changes in allocation. At latter

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[3]Introductory training sessions emphasized the underlying assumption of an interval scale implicit in the averaging of these important points.

stages in the process, minority opinions, i.e., average weights based on a subset of the group members, were analyzed to further support group debate. Later, input from other constituences (originally outside the process) was easily incorporated.

5.1 Results

This implementation represents a single data point and, hence, results are quite tentative. However, the study represents an actual DSS implementation, and its usage over a three-year period provides a significant opportunity to critique DSS concepts. Two major insights emerged from this study: (1) the critical relationship between DSS and the more traditional MIS functions and (2) the characteristics of third generation DSS technology, particularly DSS technology applicable to the public sector.

One general trend in DSS research centers on the appropriate role of the end user/decision maker and the ability of the DSS to reduce his/her dependence on the existing MIS function. Rockart and Flannery (1981) found this desire for independence to be a major factor behind end user computing. This potential gulf between DSS builders and traditional MIS designers is widened by the use of prototyping or adaptive design by DSS builders. This design process does not stress features such as documentation and ease of maintenance that receive high priority from traditional MIS organizations (Keen and Gambino, 1982).

Another aspect of this independence is the notion that effective model-based DSS can be built with little or no attention to the "data processing" requirements. Alter (1980) suggested a taxonomy of DSS that distinguishes between "data-oriented" DSS and "model-oriented" DSS. The former emphasizes storage and access to data while the latter emphasizes formal problem represen-

tations and solution procedures. While Alter recognizes this distinction is over simplified, many DSS applications and current DSS technology reflect this dichotomy. For example, many DSS generators provide primary strength in modelling with little or no capability in data management.

This research does not support the notion that DSS design will continue to be independent of the MIS function. Specifically, the distinction between model-oriented DSS and data-oriented DSS does not appear appropriate. The DSS implemented in this study was conceived as model-oriented and initial development efforts emphasized the modeling aspects of the system. And yet, experience demonstrated that the capability to link the model to the large transaction data base was critical throughout the prototyping effort. We speculate that successful DSS applications will generate requirements to link the DSS to the basic data processing systems in the organization. This DSS implementation significantly altered both the data definitions and the data flow associated with the Board's transaction data systems. This resulted in <u>increased</u> interdependencies between the DSS user and the MIS organization. The DSS implementation served as a catalyst to generate the commitment necessary to implement a data administration function. The structure of the model became the basis for redesign of the data collection activities. While this served to help institutionalize the DSS and ensure reliable input data for the allocation model, it also created the need for end-users to work closely with the MIS organization. As the Board expectations for data quality increased, the credibility of the DSS became more sensitive to the data base maintenance efforts of the MIS organization. Thus, the on-going success of the DSS became directly linked to the effectiveness of the MIS organization.

Hammond (1980), Keen (1980) and others have noted the traditional reliance of public sector analysts on descriptive data analysis to support the policy analysis process. This implementation emphasized the need for the public sector model-based DSS to provide for descriptive data analysis as well. Again, had the system been unable to easily respond to this data intensive analysis, the implementation effort would have suffered.

The study suggests that DSS may provide increased opportunities for innovations in the MIS function. Much like the introduction of new products requires different management and technical practices, the design and implementation of a DSS requires approaches that differ from the more traditional MIS practices. Yet, if successful, the DSS creates an ever increasing dependence between the DSS end-user and the MIS function. This seems particularly true in the public sector where the use of such systems may result in precedence setting policies.

A second major insight relates to the characteristics of third generation DSS technology, particularly as they may apply to the public sector. Future public sector model-based DSS generators must address at least three needs: easy incorporation of an equity dimension, enhanced data analysis capabilities and increased communication capabilities.

As the Franklin County implementation proceeded, system modifications centered around both the ability to change the model and an ability to alter information processing and basic data management modules. In many cases, changes in the model structure focused on issues of equity. As Savas (1978) points out, there are a variety of conflicting ways to operationalize notions of equity. Initially, the model did not explicitly operationalize equity relationships. While some relationships indirectly created solutions which were more

"equitable," they were not explicitly formulated to do so. For example, legal constraints which required minimum levels of services offered by agencies may have their origin in the equity notion of equal outputs.

However, as the DSS evolved, the board sought to explicitly insure equity in the allocation of funds. For example, constraints forcing distribution of funds between geographical areas were added. These efforts to ensure that small, geographically isolated providers received at least a minimum allocation represented the Savas' equity concept of equal inputs per unit area. Many discussions centered around developing constraints that would reflect the Board's concern for equal access. The ability to generate model structure, to easily test and, eventually, incorporate these structural changes was an important capability. This need to consider equity issues in the public sector results in a technological demand for at least a three dimensional model. One must be able to easily accommodate program activity, time and equity dimensions in the models. This suggests that current automated spread sheet modeling languages that are essentially two-dimensional may be inadequate for end-user system development in the public sector.

Previous discussions addressed the need to link the model-based DSS to the transaction system of the organization. This linkage results in the DSS user becoming an important stakeholder with regard to procedures to define, collect and maintain elementary data. It also suggests that third generation technology must have the capability to conduct a wide range of data analysis. As previously mentioned, this type of analysis has become standard practice for most public sector policy analysts. The need is to provide a single DSS that can adequately provide both modeling and data management capabilities.

Finally, third generation DSS technology must place greater emphasis on communication capabilities. This study emphasized the need for alternative modes of presentation, i.e., graphical versus tabular. The incorporation of a graphics capability in DSS is widely recognized. However, this study suggests that the communication needs for a public sector DSS extend beyond providing for alternative modes of presentation. Public sector analysts have significant requirements for distribution of the results of their analysis. This distribution normally takes the form of reports, memos, and/or press releases. This suggests si nificant benefits will be gained by linking the DSS into the automated office environment. For example, data related to the model-based DSS should be easily accessible by the word processing system within the office.

The growing research findings relating to the use of adaptive design or prototyping for DSS were strongly supported by this implementation. A prototyping design strategy similar to those discussed by Keen (1980), Keen and Scott-Morton (1979) and others was used to design the DSS. While this strategy proved effective, it also created high expectations on the part of the user for easy modifications. As the DSS grew in complexity, meeting these expectations became difficult. The modular design of this system, which explicitly recognized a need for model management, proved crucial to meeting these high expectations. The authors were able to evolve a matrix-generation language with self-contained high-level commands and flexible user interface with little or no impact on the command structure for the data or information management components. Further, each component proved necessary to the success of the implementation. These experiences suggest that while prototyping is successful as a general strategy, structured design concepts and associated design aids are quite important.

This study also provided insight into the process used by Board members to validate the model and the DSS. This process appeared to have three distinct stages. The first stage was the acceptance of the conceptual structure for modeling a mental health system (the BSS model) and for utilizing a multicriteria allocation model. This stage involved fairly abstract debates at the Board level involving (1) comparison of the BSS Model with other models of a mental health system, (2) reviewing alternative processes for obtaining information about the impact of allocation strategies, and (3) reviewing alternatives for conducting sensitivity analyses.

The second stage involved a macro-operational verification in which inputs to the model were varied and trends in output were examined to determine if the outputs of the model made intuitive sense or could be logically accounted for. This stage resulted in structural changes to the model and helped to established the content of several management reports.

Finally, the third stage involved validation through micro-operational sampling. This consisted of individuals selectively examining input data, model parameters and tracing outputs at very detailed levels. Evaluations were made based on personal experience or independent data sources. For example, a Board member might ask to see the unit cost for a particular type of childrens' service at a particular agency because he/she had been a provider in that environment. At this point, the implementation became linked to the ability to trace the origins of these parameters to the actual day-to-day transactions data base. If inconsistencies were found or new formulations developed, the transaction data base had to be used to provide new input to the model. On several occasions, the transaction data base was used to clarify demand characteristics or system demographics that were not explicitly incorporated into the model. Had this

capability been lacking, concerns about data quality would have impeded the implementation process and the DSS would not have been effective. Thus, while the model-based DSS basically operated on files extracted from a large transaction data base, the ability to easily interact with the transaction data base still played a major role in the implementation process.

5.2 Impact On the Community Mental Health System

It is important to note the impact of implementing this DSS on the total mental health system. As noted in Section 2, a DSS should serve as a learning support tool that is capable of addressing both strategic and operational issues. For example, in this study a decision to transfer the budget for mental retardation services to another community board was arrived at and justified, in part, by examining the allocation models developed for both areas. This examination showed programmatic independence (e.g., no shared resources or facilities) and led to a conclusion that community level goals for these two area were not in conflict.

Similarly, the system was used to illustrate the impact of alternative cost accounting approaches, to communicate the impact of federal fund-matching requirements and to examine a wide range of operational-level issues. Its uses have evolved beyond providing direct support for the allocations process. For example, extensive "what if" analysis has been performed in the context of contingency planning for the success or failure of a proposed tax levy.

The DSS also became a focal point to revamp data collection processes, to establish new controls over system-wide data flows and to create or legitimize new data requirements. As a direct result of this system implementation, a completely new data collection format was created and a new collection process

institutionalized. This effort established new validation procedures used in acquiring data as well as provided a means to train providers on the BSS model of the mental health system.

The quantity of cost and service-related data obtained from agencies was substantially increased (by nearly a factor of two) over previous years. The agencies were asked, for the first time, to indicate preferences on budget reductions, i.e., where and at what level they would place lower limits.

As might be expected, this new information management effort led to a desire for greater control over data quality and expansion of the types of data made available. Prior to the implementation of the DSS, such cooperation and involvement in the collection and quality control of data were lacking. To a large extent, the DSS created a planning process that justified the effort and cost necessary to provide such data. Since these data were also used for other financial and policy analysis tasks, the DSS produced a significant secondary impact on Board functions.

Finally, the process established well-defined points within the budget process where priorities were established and decisions made. This had and will continue to have a fundamental impact on the mechanism by which the community can influence allocations. In essence, the Board established, for the first time, direct linkages between a conceptual model of a Mental Health system, how such a system should function (goals), and the allocation process employed to achieve these goals.

6. Conclusions

Generalizations cannot be made from a single data point. However, the external validity of these experiences is high in that the system was successfully

implemented and continues to be used both for allocations decisions as well as for "what if" planning questions. Further, these experiences appear generally consistent with the growing body of research on DSS, and thus merit an attempt to draw conclusions.

First, process, i.e., the way a system or organization arrives at a decision, is critical in public sector decision making. Perhaps the most fundamental conclusion of this work is the need for the management scientist to provide a process-support aid rather than a model that provides an answer, i.e., a product-oriented aid. Thus, the importance of providing a range of learning and decision aids within an integrated, yet adaptive system is stressed.

Secondly, the emerging theory of DSS addresses a blend of design strategy, system characteristics and required technological building blocks. This work supports most current thinking with regard to these areas. Prototyping as a design strategy proved effective both in terms of defining user information needs as well as providing a mechanism to support user and analyst learning. The system characteristics of adaptability, flexibility, modularity, simplified man-machine interface, and alternative modes of presentation proved necessary to successful implementation. Thus, we find empirical support for the basic principles of DSS.

Third, model selection and formulation need careful attention. The model structure must match the problem structure, but it must also support decision maker understanding. Institutionalization of a DSS that uses a complex model is facilitated when the model serves both as an analytic tool and as a conceptual model. Care must also be taken to circumvent model usage traps. In a prototyping/evolutionary environment, the analyst must closely scrutinize model modifications in order to avoid the temptation of solution manipulation and

insure model integrity. Failure to do so can invalidate the entire DSS while still appearing (at least to the untrained eye) to perform correctly.

Fourth, the distinction between model-oriented DSS and data-oriented DSS and the notion of independence for DSS users does not appear appropriate given these experiences. This system was conceived as a model-oriented DSS and initial efforts were directed toward the modeling aspect of the system. And yet, experience demonstrated that the capability to link the model to a large transaction data base was very important. DSS users cannot remove themselves from the need to examine, verify, and communicate fundamental data. To be effective, the DSS has to provide the means to access this elementary data in a timely fashion. We speculate this will become a feature of most successful model-oriented DSS generators. That is, to be successful, there will be pressure, in fact requirements, to link the DSS to the basic data processing of the organization. From a management perspective, this will result in a need to better coordinate DSS and MIS design efforts.

Fifth, the importance of addressing equity issues is stressed. The notion of equity in public policy is, in itself, a major research issue. This study suggests future DSS technology must enable the user to incorporate an equity dimension as well as activity and time dimensions. This indicates public sector applications require a DSS generator that extends beyond the two dimensional framework currently represented by financially-oriented DSS generators. The fact that DSS generators in the public sector must be at least three-dimensional increases demands for flexiblity and sophisticated forms of presentation.

Finally, the benefits of DSS are difficult to assess a priori. As Keen (1980) suggests in the concept of value analysis for DSS, the benefits of DSS will include such issues as support of organization change, support of individual

learning and improved management of the technological growth of the organizations. This work indicated that significant systemwide impact occurred and should be explicitly recognized in the evaluation of the success or failure of the DSS effort. The DSS affected fundamental areas such as learning, organizational development, data processing and decision process framing. It influenced user learning by providing the means to investigate the complexity of the problem in a systematic manner. It affected organizational development by unfreezing positions and attitudes concerning both the mission of the Board as well as the structure of the allocation process. It affected data processing by providing the felt need and political support necessary to revamp data collection procedures and to increase the quality and integrity of their data base. Finally, it provided the means to frame the decision as one of tradeoffs between goals rather than increases or decreases in specific budget line items. This not only changed the allocation decision process but helped to institutionalize a goal-oriented planning process.

FUNCTION

ENVIRONMENT	Crisis stabilization	Growth	Sustenance
Protective	Psychiatric ward of a state hospital	Private psychiatric hospital	Long term care in a state institution
Supportive	Twenty-four hour community emergency center	Outpatient service at a community mental health center	Chronic patient deinstitutionalization
Natural	Court appointed probate screening	Direct group counseling at the work place	Chronic patient living with foster family

Figure 1. The Balanced Service System Service Categories

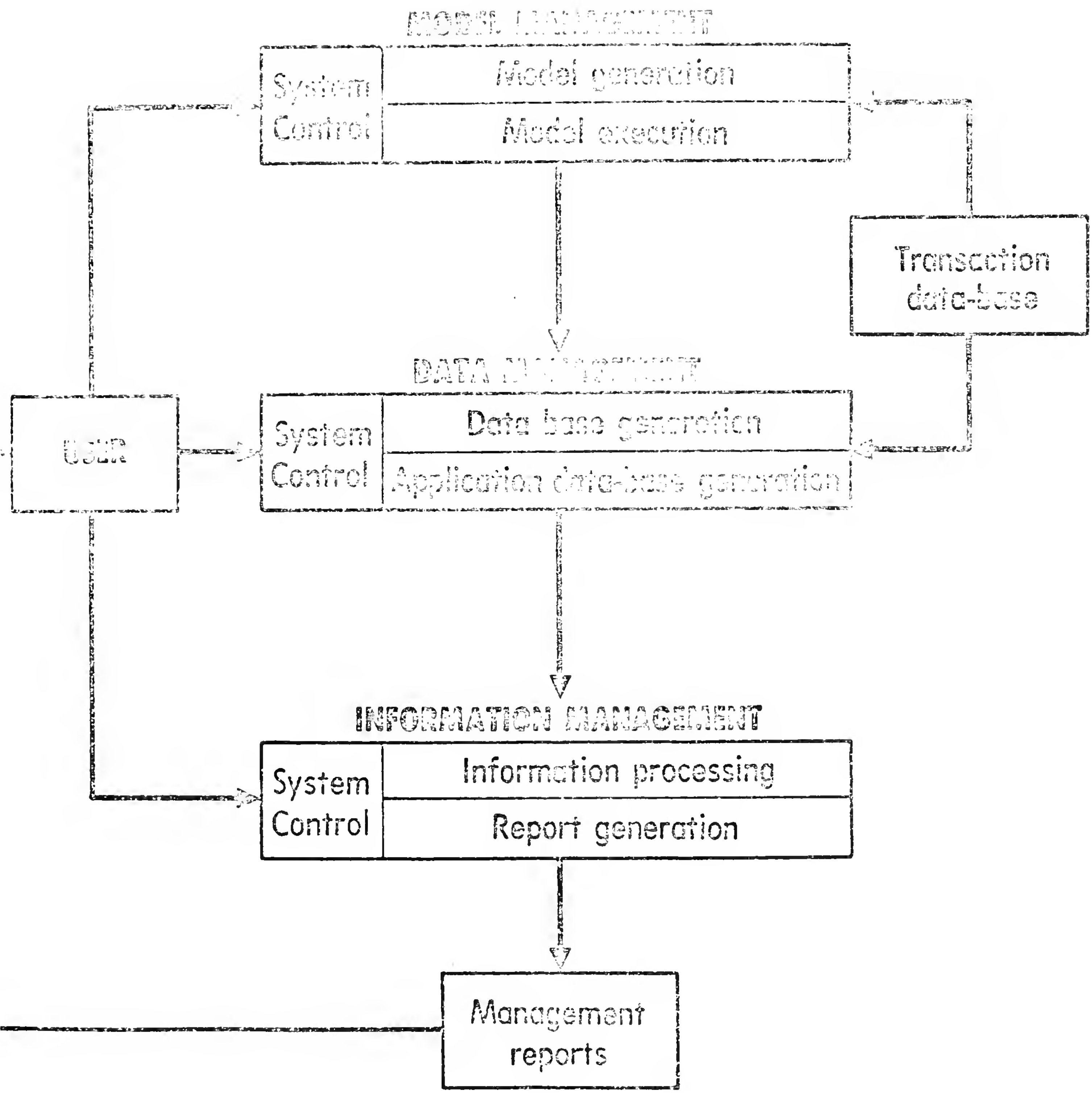

Figure 2. Decision Support System: Framework

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